Industry 4.0

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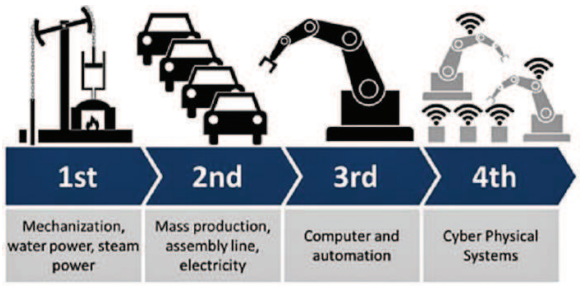
Abstract— The term **"industry 4.0"** refers to the concept of factories in which machines are augmented with wireless connectivity and sensors, connected to a system that can visualise the entire production line and make decisions on its own.

I. INTRODUCTION

The term Industry 4.0 was first publicly published in 2011 as "Industrie 4.0" by a group of representatives from different fields (such as business, politics, and academia) under an initiative to enhance the German competitiveness in the manufacturing industry

This era is in the midst of a significant transformation regarding the way we produce products. This transition is so compelling that it is being called Industry 4.0 to represent the fourth revolution that has occurred in manufacturing. From the first industrial revolution (mechanization through water and steam power) to the mass production and assembly lines using electricity in the second, the fourth industrial revolution will take what was started in the third with the adoption of computers and automation and enhance it with smart and autonomous systems fueled by data and machine learning.



II. DEFINITIONS

IoT

IoT is short for Internet of Things. The Internet of Things refers to the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other internet-enabled devices and systems. Your Wi-fi doorbell, or smart refrigerator are everyday examples of IoT devices.

IIoT

Industrial Internet of Things (IIoT) is a subset of IoT, aimed specifically at industrial applications. IIoT is about connecting machines to other machines/data management and the optimization and productivity that is possible to make "smart factories."

Industry 4.0

This is a phrase coined in Europe. It means the same as IIoT and refers to the fourth industrial revolution, The term is interchangeable with IIoT and is now recognized globally.

Industry 4.0: Sub Components

To take full advantage of IoT, IIoT, and Industry 4.0 benefits, there are several components that must first be understood. More about these components are given below..

1. The Cloud

Utilizing the intranet to access data at an location where internet connectivity is possible the cloud is an IT paradigm. Moving fror conventional servers to the cloud empower the availability of data wherever and whenever needed. Furthermore, the cloud enable companies to focus on their core expertis rather than investing large sums of money o computer infrastructure and maintenance. Cloud computing relies on the sharing of resources to achieve economies of scale, like a public utility.

2. Sensors And Connected Devices

Just about every product bought today is equipped with an IP address. Those who use Nest at home, view home cameras from a mobile phone, or start a car from an app are all using IOT. IIOT provides the same capabilities, but for larger pieces of equipment. This typically requires integration into corporate software like Manufacturing Resource Planning (MRP), Product Lifecycle Management (PLM), or asset management software. In some cases the equipment is older and might not have internet connectivity; thankfully, there are numerous sensors available on the market for making old equipment compatible.

3. Augmented Reality

Data is available almost everywhere, which also increases our urge to be able to view it almost anywhere. Providing data with context almost immediately makes it more meaningful. This is where augmented reality (AR) comes in, and it can be implemented in many variants:

- Phone/Tablet: When you hold up your device to view a piece of equipment, a digital overlay can provide additional data regarding that equipment, KPI's, Graphical Data, Schematics, Graphical Data, and Digital twin data, among others.
- Assisted Reality Wearable: Like Google Glass, this displays an image of computer screen typically to one eye, providing on-the-spot data.
- Immersive Augmented Reality Wearable: Typically, this involves glasses that attempt to cover your most of your viewing field, with the potential to show KPI's, graphical data, schematics, and digital twin data, among other functionality.

It doesn't take much to notice that phone, tablet, and immersive AR wearables share many of the same display opportunities. Phones and tablets are excellent in many use cases, but the distinguishing factor comes in when you need to perform work at the point-of-use. In these cases, wearable devices are easier to utilize.

4. Artificial Intelligence

Artificial Intelligence (AI) is the phenomenon of computer and machine learning. Devices are now available that recognize their environment and begin to take actions based on that environment to maximize achieving a goal or a result. AI is also now being used to recognize and separate parts (sorting good from bad parts). We have seen it in the food industry for years, but it is now capable of sorting parts by size or in so cases a good part vs a bad part.

5. Big Data

Big data refers to data sets that are so big and complex even traditional data-processing application software are inadequate to deal with them. Big data challenges include capturing data, data storage, data analysis,

search, sharing, transfer, visualization, querying, updating, information privacy, and data source.

6. Digital Twin

Digital twin is a digital representation of a physical asset. Digital twins can be used to show how an item is serviced. This can also be used in combination with AI tool sets, software analytics, and real-world data to create living digital simulation models that update and change along with their physical counterparts.

7. Cybersecurity

The increased demand for cloud and internet-based services increases the need for protection of computer systems from theft of or damage to their hardware, software or electronic data, as well as from disruption or misdirection of the services they provide. Cyber security includes controlling physical access to system hardware, as well as protecting against harm that may be done via network access, malicious data and code injection.

8. Additive Manufacturing and Digital Scanning

The significant price reduction of digital scanners and 3D printers enables much faster prototyping of products/product development. A few large companies are now looking to use 3D printing in production, allowing more complex parts to be made in significantly less time.

III. KEY COMPONENTS OF INDUSTRY 4.0

The key components of successful implementation of Industry 4.0 are given below. Every organization large or small should concentrate and inculcate these components in every activity that they undertake to conduct the business, most important are points A, D,F and G.

F. Greater Customization through Additive Manufacturing. ...

G. Full Integration of Advanced Analytics. ...

H. A Move Beyond Postmodern ERP. ...

I. Widespread Incorporation of the Internet of Things. ...

J. Increased Reliance Upon the Cloud. ...

K. Autonomous (and Cooperative) Robots. ...

L. Enhanced Cybersecurity.

M. Effective Risk Management

N. Discipline and Commitment.

O. Fairness to Employees and Customers.

P. Transparency and Information Sharing.

Q. Corporate Social Responsibility.

R. Regular Self-Evaluation

IV. BENEFITS OF INDUSTRY 4.0

Predictive Maintenance

Years of machine data analysis reveal events that have triggered failures in equipment, coupled with real-time monitoring, can warn of performance trends. This can provide advanced warnings when pieces of equipment are about to fail. In turn, workers can schedule equipment maintenance at a convenient time rather than reactive maintenance when the machine crashes and the assembly line comes to a stop.

Demand Prediction

Big data analysis can review market trends associated with your commodity, AI can then assist with inventory review and tracking market pricing. The result is having more accurate demand prediction, along with the ability to buy at market lows. This ultimately results in improved margins.

Inventory Optimization

Real-time inventory management is available with scanners connected to inventory management systems. AR devices can assist with picking/kitting instructions, with potential productivity improvements up to 40 percent.

Productivity

Many companies utilizing AR work instructions have reported 30+ percent productivity on certain operations. Companies using this technology have also realized improved quality over paper instructions for complex tasks.

Expedited And Improved Training

The utilization of VR and AR in training scenarios means that someone wishing to learn a new operation can simply put on a set of glasses and instantly get guidance. Since this is an experiential activity versus reading a manual or sitting in a class, retention is improved and training time is significantly reduced. Once the training application is completed the trainer also does not have to spend all that time teaching the same class over and over.

Improved Robotics

Once upon a time, robots were all caged, preventing them from contacting a shop floor worker. With the advancement in sensor technology, robotics can be used in an open environment, the combination of AI and smart robots results in robots that can adapt to challenges in their environment and make the best possible choice to accomplish a task.

Costs

Given how great this all sounds, you may be starting to think about the associated costs. Many people get to this point and assume the cost is prohibitive. But the fact is that some of your new machines may already be compatible. Cost is entirely dependent on each situation and facility, but talk to an Industry 4.0 specialist, and you may be surprised to find you can get started for as little as $20,000. This allows businesses both big and small to get up and running while still being mindful of their bottom line.

V. EMERGING TRENDS GLOBAL

Today's supply chain technology solutions address **manufacturing** needs in a variety of areas, including: **Manufacturing** Optimization. Logistics Optimization. Sales and Operations Planning.

IoT is transforming almost every surface into a sensor for data collection and providing real-time insights for manufacturers. This ability to collect data from so many sources combined with increasingly powerful cloud computing is finally making big data usable. Manufacturers can slice and dice data in ways that provide them with a comprehensive understanding of their business. This enables them to improve production, optimize operations, and address issues before problems arise.

Assistive technologies, such as augmented reality (AR) and virtual reality (VR), will continue to create mutually beneficial partnerships between man and machine that positively impact manufacturers.

Due to VR software interfacing seamlessly with computer-aided designs, product developers can use VR to quickly make modifications and additions to products during the product design stage before they go into modeling and manufacturing processes. AR and VR can also

decrease inspection time and assist in detecting errors in addition to improving workers' sight line, which enables them to complete tasks faster.

For example, by using AR devices such as electronic glasses or goggles, computer-generated graphics can be placed in a worker's field of vision that provide him with real-time help when it comes to performing a task. AR technology can also be used with cameras and sensors for training. Workers can be shown how to perform a task and use the data feed to correct mistakes, which makes it possible to quickly and effectively train unskilled workers for high-value work.

Manufacturers will benefit from faster, less expensive production as a result of 3D printing. It makes rapid prototyping, which is a highly cost-effective way for product designers to test and troubleshoot their products, possible. In addition, it enables manufacturers to produce items on demand instead of having to manufacture and warehouse them.
The expensive and time-consuming process of tooling for manufacturers is already being transformed by 3D printing. Historically the production of molds, jigs and fixtures used in the mass production of heavy equipment took months, was very expensive and typically involved utilizing tooling companies headquartered overseas. 3D printing makes it possible for tooling to be cost effectively completed on-site, in days, and has already been embraced by the automotive and aerospace manufacturing industries.

VI. CONCLUSION

As Countries push to remain competitive with manufacturing throughout the rest of the world, it is imperative that all companies—large and small—investigate and embrace Industry 4.0. In most cases, the technology will provide such enhancements to the bottom line that the investment will pay for itself within just a year or two. We can hold out and wait for the technology prices to drop, but competitors might not share that mentality.

REFERENCES

[1] Industry 4.0 Wikipedia